PHY 203 Modern Physics Spring 2023

Instructor: Dr. Truong Le (he,him,his)
Office: Trexler 266B
Email: tle@roanoke.edu

Credits for the course: 1
Lectures Time: MWF 1:10-2:10 pm
Lectures Room: Trexler 272

Class Environment: I consider this classroom to be a place where we will treat one another with respect, creating an environment that welcomes individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability and other visible and nonvisible differences. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. To minimize distraction, please put your cell phone to silent mode before any lecture. The instructor has the right and the authority to expel anyone who disrupts the lecture or behaves inappropriately at any time. **This syllabus will continue to change with students' notice.**

Office Hours: MWF (10-12 pm), and by appointment.

Course Description: Special relativity, particle properties of waves, wave properties of particles, Heisenberg uncertainty principle, Bohr theory, elementary quantum theory and its application to the hydrogen atom. We will also survey selected applications of special relativity and quantum mechanics.

Textbook: *Modern Physics for Scientists & Engineers* (2nd edition) by Thornton and Rex.

Purpose of the Course: In this semester we hope to give you the background and execution of 20th century revolutions in physics. We want to further develop your physical intuition, to extend your physics experience more deeply, especially into relativity and quantum mechanics, to enhance your capacity for solving problems both qualitatively and quantitatively, and for you to understand the motivation and process of the development of modern physics. Major topical areas are: relativity, quantum nature of light, matter waves, and quantum mechanics.

Goals of the Course: The primary goals of this course are:

- Attain a clear understanding of the main concepts of special relativity and quantum mechanics.
- Appreciate the problems with classical physics that led to the development of these theories.
- Understand the relevance of the two theories to modern science and technology.
- Gain additional experience using computers (mainly *Mathematica*) to solve physics problems.

Participation/Attendance: You will work on a tutorial (worksheet) every class in a group. You will need to submit your tutorial online (inquire) after every class. This course expects you to spend at least 12 hours per week in and out of class. You will rotate to a new group every week.

Homework: Due to the nature of problem solving, I expect that you will work together toward a solution. However, I also expect that you will create an original solution to each assigned problem. Substitutions and simplifications should **NOT** be left to the "reader" (that's me) to figure out. If necessary, words and phrases need to be properly placed so that I can follow your train of thought. Problem sets are your final draft essays and/or compositions that display the fruit of your higher-level critical thinking skills, so you need to view them in that light. If you do not, I will return them to you for completion. You need to submit all assigned problems on-time before the due date to receive full credit. **Late submission: 10% will be deducted if submitted by 3 pm on the due date, and additional 10% thereafter.**

Quizzes: You will take a quiz every Friday. The problems are mainly from the graded homework or completed tutorial with some modifications. No makeup, except, excused absence.

Laboratory: The PHYS 203 lab component is taught in a separate meeting by a different instructor (Dr. Fatima), and will complement and ground the material being covered in this course.

Exams: The exames in this class will be take-home exams. **You may only use your book, notes, or homework.** You may use *Mathematica* or a table of integrals. You may NOT receive any assistance from anyone, including from the internet, other than Dr. Le. The days of the exams will be determined by our progress through the material and the homework assignment schedule.

Score on the Homework, Quiz, and Exam are determined by the following rubric:

Score	Description
5	The solution is correct and the writing is clear. The instructor can easily see that the student fully understands how to solve the problem.
4	The solution is mostly correct, but there may be some flaws. The writing is reasonably clear. There is evidence that the student understands the key concepts involved in solving the problem, but may not fully grasp all of the details.
3	The solution is partly correct, but there are significant errors. The writing may be hard to follow in places. There is evidence that the student does not fully understand the key concepts required to solve the problem, or that the student is unable to use those concepts in an appropriate way.
2 or less	The solution is either completely incorrect or incomprehensible. This may indicate that there are serious flaws in all aspects of the solution, or that the writing was so poor that it was impossible to follow.

Grading: Your grade in this class will be determined by a combination of class participation, homework, lab, quizzes, and exams. The separate weightings will be:

Participation/Attendance/Quizzes/Tutorial 15%

Homework 20%

Lab: 20%

Three Exams 45% (each-weighted equally)

Final Grade: Final course grades will be assigned using the following scale:

A	93% or more	C+	77-79.9%
A-	90-92.9%	C	73-76.9%
B+	87-89.9%	C-	70-72.9%
B	83-86.9%	D	60-69.9%
B-	80-82.9%	F	below 60%

MCSP Colloquium Series: This semester a series of talks will be offered which appeal to a broad range of interests related to math, computer science and physics. Participation in at least two talks is mandatory. Within one week of attending a talk you must submit (via Inquire) a one-page singlespaced paper. This paper should not only include a summary of the main content of the talk, but also a personal contemplation of the experience. This will be part of the participation grade.

Accessible Education Services (AES): located in the Goode-Pasfield Center for Learning and Teaching in Fintel Library. AES provides reasonable accommodations to students with documented disabilities. To register for services, students must self-identify to AES, complete the registration process, and provide current documentation of a disability along with recommendations from the qualified specialist. Please contact Becky Harman, Assistant Director of Academic Services for Accessible Education, at 540-375-2247 or by e-mail at aes@roanoke.edu to schedule an appointment. If you have registered with AES in the past and would like to receive academic accommodations for this semester, please contact Becky Harman at your earliest convenience to schedule an appointment and/or obtain your accommodation letter for the current semester.

Academic Integrity: Your learning and integrity are at the core of your RC education. For this reason, you must follow the rules outline in the College AI policies. See https://www.roanoke.edu/inside/az index/academic _affairs/academic integrity. **If I become aware of a possible violation of these guidelines, I am contractually obligated to report it to the Academic Integrity committee.**

Course Schedule: A tentative schedule of topics for the course is given below. I reserve the right to make any changes to this schedule that I feel are necessary.

Date	**Topic**	**Reading**	**Lab**
Jan. 18	Introduction to the course	–	HPS 1: Imagination and
20	Classical physics	1.1-1.3	Creativity (Jan 19)
23	Atomic theory & unresolved questions	1.4-1.6	
25	The ether and Michelson-Morley	2.1-2.2	HPS 2: Einstein and
27	Einstein postulates; Lorentz	2.3-2.4	Michelson-Morley (Jan 26)
30	Time dilation and length contraction	2.5-2.6	
Feb 1	Experimental verifications	2.7	Lab 1: Speed of
3	The twin paradox and spacetime	2.8-2.9	Light I and II (Feb 2)
6	Relativistic momentum and energy	2.11-2.12	
8	Relativistic collisions	2.11-2.12	Speed of Light
10	Review/catchup		Labs (cont'd) (Feb 9)
11-12	**Exam 1** (chapters 1,2)		
13	The Electron and Its Charge	3.1-3.2	Lab 2: e/m ratio (Feb 16)
15	Line spectra	3.3-3.4	
17	Blackbody radiation	3.5	HPS 3: Robert Millikan,
20	Photoelectric effect	3.6	in perspective (Feb 23)
22	Compton effect	3.8	
24	Rutherford scattering	4.1-4.3	Lab 3: Photoelectric
27	The Bohr model	4.4-4.5	Effect (Mar 2)
Mar 1	Review/catchup		
2-3	**Exam 2** (chapters 3,4)		HPS 4: Planck and Bohr,
13,15	De Broglie waves and scattering	5.1-5-3	in perspective)(Mar 16)
17	The Uncertainty Principle	5.4-5.6	
20,22,24	Probability and wavefunctions	5.7-5.8	Lab 4: Young's 2 Slit (Mar 23)

27,29,31	The Schrodinger equation	6.1	HPS 5: Interpretations
Apr 3	Expectation values	6.2	of QM (Mar 30)
5,7	Infinite square wells	6.3, 6.5	Lab 5 Function Generator/
10	Barriers and tunneling	6.7	Oscilloscope (Apr 6)
12	Alpha decay and scanning microscopes	6.7	Lab 6: Circuits/Oscillators/
14,17	The hydrogen atom	7.1-7.2	Oscilloscopes (Apr 13)
19	Quantum numbers	7.3	
21	Magnetic effects and intrinsic spin	7.4, 7.5	Lab 7: Radioactivity, Electron
24	Review/catchup		Diffraction, Oil Drop
TBD	**Exam 3** (chapters 5,6,7)		Experiment (Apr 20)

I have read and understood this syllabus. Sign, date, and submit this page for 10 points toward your participation grade on your first day of clas.

Student's signature: **Date:**